

A KEY TO SOME NEW WORLD SPECIES OF *TRICHOGRAMMA*
(HYMENOPTERA: TRICHOGRAMMATIDAE), WITH
DESCRIPTIONS OF FOUR NEW SPECIES¹

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Although *Trichogramma* spp. have been used for several decades for the biological control of a variety of lepidopterous pests, no serious exploratory surveys have apparently been made for new species occurring in different parts of the world. This is especially true of some continents, such as South America, Africa, and parts of Asia. In the course of a biosystematic study of the genus, circular letters sent to entomologists in various countries have drawn some response and as a result, 4 new species of *Trichogramma* have been found in the New World, and they are described in this paper. A key to most of the New World species has also been included. There is every likelihood of more being present not only in the continental areas, but also in the adjoining islands, and a thorough search may prove quite rewarding.

The need for a reliable key to identify *Trichogramma* spp. has always been felt by entomologists working with this group of insects. Not all characters dealt with in the following key are ideal (in the sense stated by Mayr *et al.*, 1953) inasmuch as some of the characters apply only to either the females or the males, even the most important ones cannot be observed directly, and some are not necessarily absolute. Nevertheless, this key will hopefully facilitate more reliable determination than hitherto. The following key and the descriptions are based on specimens that were reared on eggs of *Corcyra cephalonica* St. at 80° F. ($\pm 2^\circ$) and 50% R. H. in the laboratory (with the exception of *T. bennetti* sp. nov., *T. semblidis* (Auriv.), and *T. retorridum* (Gir.), of which we did not have live cultures). For further details of the generalized male genitalia of *Trichogramma* and descriptions of the better known species, see Nagarkatti and Nagaraja, 1968 and 1971 respectively.

KEY TO THE NEW WORLD SPECIES OF *Trichogramma*²

1. Dorsal expansion of gonobase broad, without distinct side lobes but with rounded posterior extremity; aedeagus broad, shorter than apodemes, both together shorter than genitalia *T. bennetti* N. & N., n. sp.

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² Although an attempt has been made to include in the key as many species as possible from the New World, we have necessarily had to omit mention of *T. helocharæ* Perkins, *T. intermedium* How., and *T. koehleri* Blanchard, specimens of which we could not obtain for examination.

- Male genitalia not as above 2
- 2. Chelate structure almost reaching level of gonoforceps 3
- Chelate structure distinctly below level of gonoforceps 4
- 3. Antennal hairs nearly 4 times maximum width of flagellum; dorsal expansion of gonobase short, appearing cup-shaped when viewed from caudal end; wing remigium with regularly arranged trichiae *T. maltbyi* N. & N., n. sp.
- Antennal hairs about 2 times the maximum width of flagellum; dorsal expansion of gonobase triangular with slight constrictions at base; wing remigium with irregularly arranged trichiae *T. retorridum* (Girault)
- 4. Median ventral projection minute; tip of dorsal expansion of gonobase distinctly below level of chelate structure *T. rojasi* N. & N., n. sp.
- Median ventral projection small, but not minute; tip of dorsal expansion of gonobase reaching level of chelate structure or extending beyond it 5
- 5. Males dimorphic; apterous males with gynecoid antennae without body reduction, alate males with normal antennae *T. semblidis* (Aurivillius)
- Males monomorphic 6
- 6. Antennal hairs almost blunt, length of longest hair about 2 times maximum width of flagellum 7
- Antennal hairs sharply tapering, length of longest hair 2½ to 3 times maximum width of flagellum 8
- 7. Fringe on tornus of fore-wing about 1/10 the width; male antenna with more than 50 hairs *T. californicum* N. & N., n. sp.
- Fringe on tornus of fore-wing 1/6 to 1/8 the width; male antenna with less than 50 hairs 9
- 8. Longest antennal hair about 2½ times the maximum width of flagellum; females with little or no black pigment; dorsal expansion of gonobase somewhat broad 10
- Longest antennal hair about 3 times the maximum width of flagellum; females dark colored; dorsal expansion of gonobase somewhat narrow; arrhenotokous and thelytokous strains present *T. semifumatum* (Perkins)
- 9. Chelate structure far below gonoforceps; median ventral projection almost reaching level of chelate structure; females moderately dark with blackish prothorax and abdomen *T. fasciatum* (Perkins)
- Chelate structure close to gonoforceps; median ventral projection not reaching level of chelate structure; females yellow occasionally with black pigment only in mesoscutum, sides of parapsides and anterior part of abdominal segments *T. perkinsi* Girault
- 10. Ovipositor distinctly longer than hind tibia; wing remigium with regularly arranged trichiae; females completely devoid of black pigment *T. minutum* Riley
- Ovipositor as long as or slightly shorter than hind tibia; wing remigium with somewhat irregularly arranged trichiae; females with anteriormost abdominal terga black *T. pretiosum* Riley

Trichogramma bennetti Nagaraja and Nagarkatti, new species
fig. 1-7

Male: Pigmentation based on a few available specimens, light yellow with blackish thoracic sclerites and abdomen. Fringe on tornus of fore-wing about

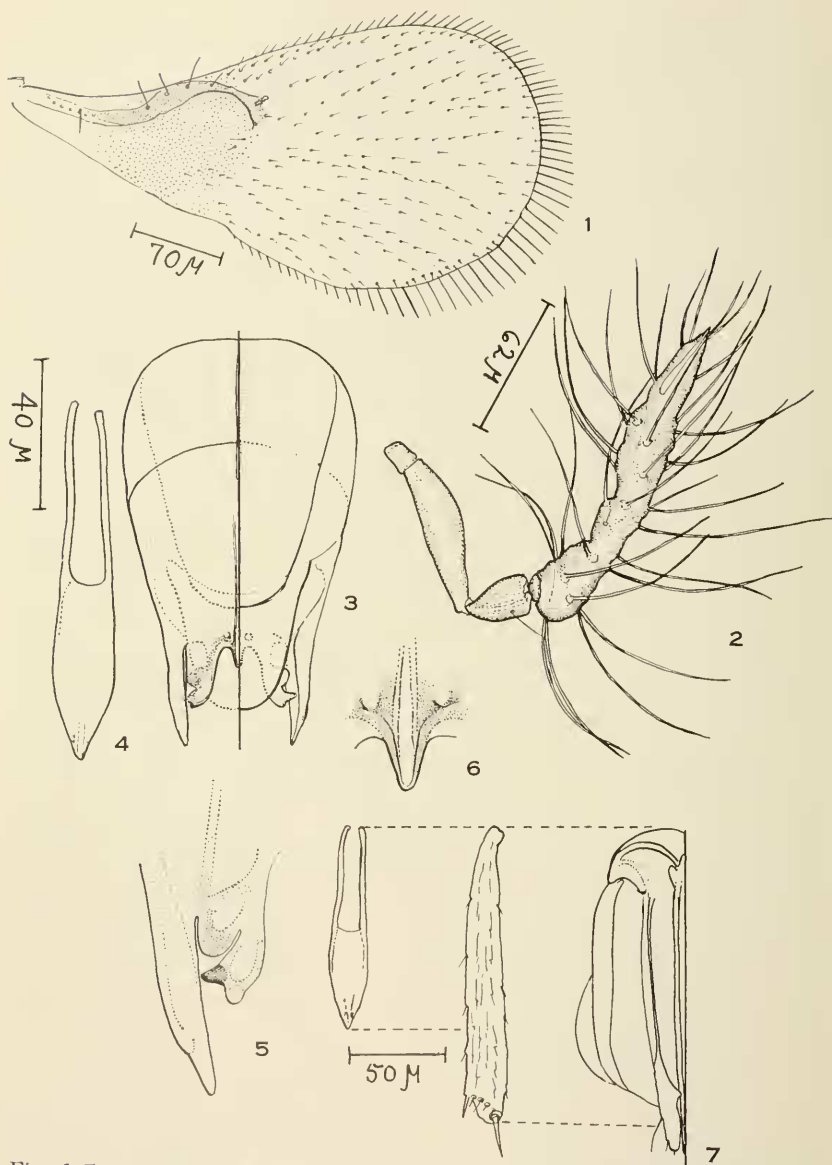


Fig. 1-7. *Trichogramma bennetti*. n. sp. 1, forewing. 2, antenna of male. 3, male genitalia. 4, aedeagus. 5, enlarged view of median ventral projection. 6, enlarged view of chelate structure. 7, relative lengths of aedeagus, hind tibia and ovipositor.

$\frac{1}{6}$ the width of wing (fig. 1). Antennal hairs finely tapering and long, the longest being nearly 3 times the maximum width of flagellum (fig. 2).

Genitalia (fig. 3): Dorsal expansion of gonobase highly chitinized and simple with characteristically rounded, bulbous posterior extremity reaching level of chelate structure. Sides of dorsal gonobase expansion nearly parallel. Chelate structure (fig. 5) appears bilobed and is located far below tips of gonoforceps. Median ventral projection (fig. 6) minute but visible. Median ventral ridge paired, extending to about one-third the entire length of genitalia. Aedeagus (fig. 4) stout but posterior end pointed, appearing somewhat spear-shaped; shorter than apodemes, both together slightly shorter than genitalia and distinctly shorter than hind tibia (fig. 7).

Female: Pigmentation same as of male. Ovipositor slightly longer than hind tibia (fig. 7).

Holotype: Male from Trinidad (West Indies); ex eggs of *Hypsipyla ferrealis* Hmps. on *Carapa guyanensis*; 1968 (F. D. Bennett coll.) in the U.S. National Museum, Washington, D.C., USNM no. 71352 mounted on slide. Male genitalia dissected and mounted on slide. Allotype female also mounted on slide. Paratypes in Commonwealth Institute of Biological Control, Indian Station, Bangalore, India.

Remarks: *T. bennetti* was received from Dr. F. D. Bennett, CIBC West Indian Station, Trinidad, who reared it from eggs of *H. ferrealis* on *Carapa guyanensis*. Myers (1932) mentions an unidentified species of *Trichogramma* from the same host in Guyana, which could very well be the same as *T. bennetti*. If this is true, it is possible that the species occurs on the South American continent as well as on the adjoining islands.

Trichogramma californicum Nagaraja and Nagarkatti, new species

fig. 8-14

Male: Dull yellow with blackish thorax and abdomen. Fringe on tornus in fore-wing about $\frac{1}{10}$ the width of wing (fig. 8). Antennal hairs somewhat blunt and short, the longest hair being nearly twice the maximum width of flagellum (fig. 9).

Genitalia (fig. 10): Dorsal expansion of gonobase highly sclerotized and triangular with slight constrictions at base; posterior tip of dorsal expansion of gonobase reaching level of chelate structure. Chelate structure (fig. 12) well below tips of gonoforceps. Median ventral projection (fig. 13) distinct and pointed, below level of chelate structure. Median ventral ridge paired, extending anteriorly to about $\frac{1}{2}$ the length of genitalia. Aedeagus (fig. 11) slightly longer than apodemes, both together distinctly shorter than hind tibia (fig. 14).

Female: Color same as male. Ovipositor almost equal in length to hind tibia (fig. 14).

Holotype: Male from Alturas, Modoc County, northeastern California, U.S.A.; ex eggs of *Hemerocampa pseudotsugata* (McD.); 1967 (R. D. Doult coll.) in the U.S. National Museum, Washington, D.C., USNM no. 71353. Male and dissected male genitalia mounted on

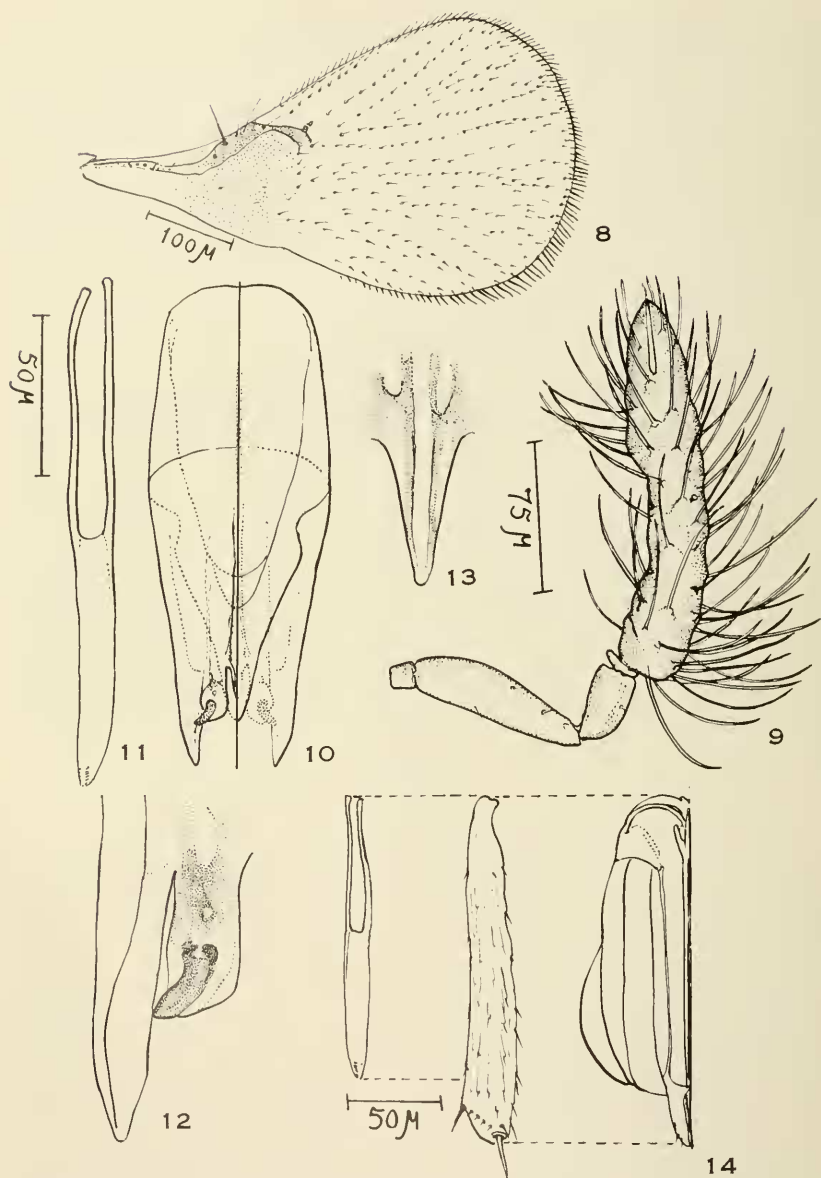


Fig. 8-14. *Trichogramma californicum*. n. sp. 8, forewing. 9, antenna of male. 10, male genitalia. 11, aedeagus. 12, enlarged view of chelate structure. 13, enlarged view of median ventral projection. 14, relative lengths of aedeagus, hind tibia and ovipositor.

slide. Allotype female on slide. Paratypes in the British Museum (Natural History), London.

Remarks: *Trichogramma californicum* was received from Dr. R. L. Doutt of the Division of Biological Control, University of California, Berkeley, and it had been suspected to be *T. euproctidis* (Girault).³ Examination, however, revealed that the species is vastly different from *T. euproctidis*, which is of European origin. Moreover, the 2 species cross only to a very limited extent in the laboratory. *Trichogramma californicum* was reared from eggs of the Douglas fir tussock moth, *H. pseudotsugata*, in northeastern California. Although *T. californicum* appears to belong to the *T. minutum* Riley—*T. pretiosum* Riley complex, it can be differentiated from these species by the presence of short antennal hairs, the dark pigmentation, and the ovipositor to hind tibia ratio. *Trichogramma californicum* could be considered to bear semispecies status with respect to *T. semifumatum*, with which it crosses in both directions to a limited extent (Nagarkatti and Fazaluddin, in press). It may be pertinent to mention the receipt of a population of *Trichogramma* from the Netherlands (received from Dr. M. Gijswijt of the Agrobiologisch Laboratorium, 's Graveland) which closely resembles *T. californicum* in all respects except for the slightly darker pigmentation. Moreover, eggs of *C. cephalonica* when parasitized by *T. californicum* turn grayish brown in color on the 4th day, while those parasitized by the Netherlands population turn black in color, as is usual with other species. Laboratory crossing tests between the Netherlands population and *T. californicum* have shown that they are totally reproductively isolated.

Trichogramma maltbyi Nagaraja and Nagarkatti, new species
fig. 15-21

Male: Head yellow, thorax, abdomen and hind femur dark fuscous, except for light yellow intersclerital region and propodeum and basal part of abdomen. Fringe on tornus of fore-wing about $\frac{1}{4}$ the width of wing (fig. 15). Antennal hairs finely tapering and very long, the longest hair being nearly 4 times the maximum width of flagellum (fig. 16).

Genitalia (fig. 17): Dorsal expansion of gonobase highly sclerotized with rounded sides, appearing cup-shaped when viewed from caudal end, constricted at base. Dorsal expansion of gonobase below tips of chelate structure. Chelate structure (fig. 19) almost reaching tips of gonoforceps. Median ventral projection (fig. 20) minute. Median ventral ridge paired, fused anteriorly, extending to

³ *Trichogramma euproctidis* (Girault) is reported by Dr. B. D. Burks (Systematic Entomology Laboratory, U.S. Dept. of Agriculture, Washington, D.C.) to be frequently encountered in material collected in the U.S.A. which he receives for identification. This species is not included in the key as it is believed to be of European origin and has been introduced into the U.S.A. *Trichogramma evanescens* Westwood frequently observed by the authors is also excluded for the same reason.

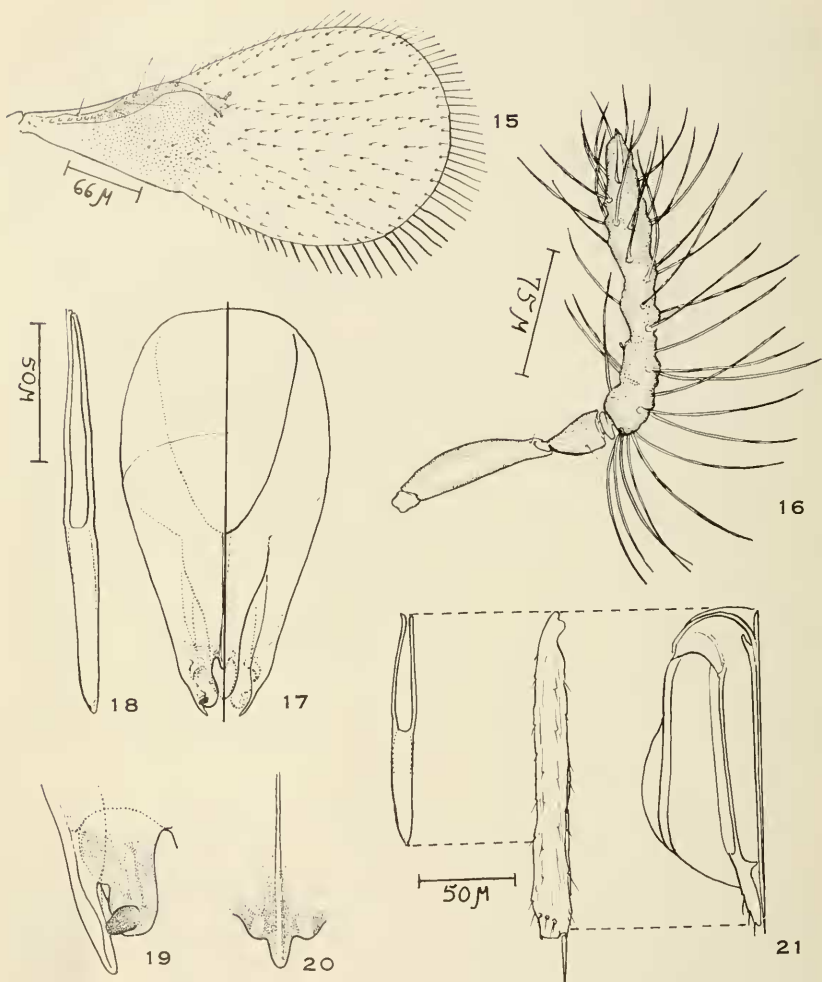


Fig. 15-21. *Trichogramma maltbyi*. n. sp. 15, forewing. 16, antenna of male. 17, male genitalia. 18, aedeagus. 19, enlarged view of chelate structure. 20, enlarged view of median ventral projection. 21, relative lengths of aedeagus, hind tibia and ovipositor.

about $\frac{1}{3}$ the length of genitalia. Aedeagus (fig. 18) as long as apodemes, both together much shorter than hind tibia (fig. 21).

Female: Color same as male. Ovipositor nearly equal in length to hind tibia (fig. 21).

Holotype: Male from Berrien County, Niles, Michigan, U.S.A.; ex eggs of *Oulema melanopus* (L.) on oats; 1968 (H. Maltby coll.) in

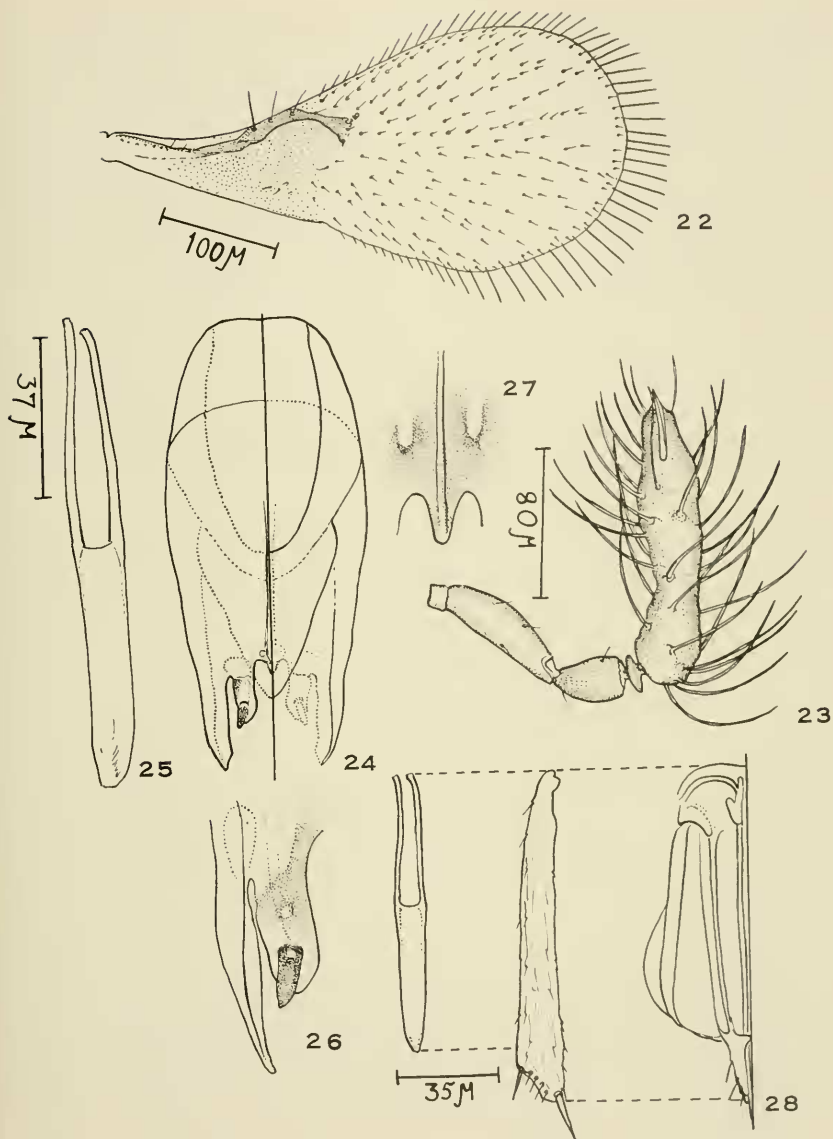


Fig. 22-28. *Trichogramma rojasi*. n. sp. 22, forewing. 23, Antenna of male. 24, male genitalia. 25, aedeagus. 26, enlarged view of chelate structure. 27, enlarged view of median ventral projection. 28, relative lengths of aedeagus, hind tibia and ovipositor.

the U.S. National Museum, Washington, D.C., USNM no. 71354. Male and dissected male genitalia mounted on slide. Allotype female on slide. Paratypes in the British Museum (Natural History), London.

Remarks: *Trichogramma maltbyi* was reared from eggs of *O. melanopus* and *Lema collaris* Say by Maltby *et al.* (1969). It was originally thought to be *T. evanescens*, a European species that has been introduced into the U.S.A., but crosses by the above authors proved that the 2 would not interbreed. Moreover, we have found that the male genitalia vastly differ in the 2 species, although the antennal hair length and pigmentation are comparable.

Trichogramma rojasi Nagaraja and Nagarkatti, new species
fig. 22-28

Male: Dull yellow with blackish thorax and abdomen. Fringe on tornus of fore-wing about $\frac{1}{6}$ the width of wing (fig. 22). Antennal hairs rather blunt, short, the longest being slightly more than twice the maximum width of flagellum (fig. 23).

Genitalia (fig. 24): Dorsal expansion of gonobase highly chitinized, triangular with blunt apex and slightly constricted base. Chelate structure (fig. 26) slightly below tips of gonoforceps. Median ventral projection (fig. 27) short. Median ventral ridge paired, extending anteriorly to about $\frac{2}{3}$ the length of genitalia. Aedeagus (fig. 25) as long as apodemes, both together shorter than hind tibia (fig. 28).

Female: Same color as male. Ovipositor slightly longer than hind tibia (fig. 28).

Holotype: Male from La Cruz, Chile; ex eggs of *Tatochila* sp. on *Trifolium* sp.; 1968 (Sergio Rojas coll.) in the U.S. National Museum, Washington, D. C., USNM no. 71355. Male and dissected male genitalia mounted on slide. Allotype female on slide. Paratype in the British Museum (Natural History), London and Collection of the Instituto de Investigaciones Agropecuarias, Sub-Estacion Experimental La Cruz, Chile.

Remarks: Dr. Sergio Rojas of the Sub-Estacion Experimental, Instituto de Investigaciones Agropecuarias, La Cruz, collected this species from eggs of *Tatochila* sp. on *Trifolium* and *Rachiplusia ou* Guén. on alfalfa and beans. This was originally believed to be either the same as or close to *T. semifumatum* (Perkins). Comparing it with specimens of *T. semifumatum* from U.S.A., we have found that they are distinct and hence consider *T. rojasi* as a distinct species.

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THE STATUS OF *ENALLAGMA TRAVIATUM* AND *WESTFALLI*
(ODONATA: COENAGRIONIDAE)

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ABSTRACT—*Enallagma westfalli* is shown to be a subspecies of *E. traviatum*, differing in the character of the superior arm of the superior appendage of the male. The subspecies *westfalli* occurs west of the Appalachians from Pennsylvania and Michigan to Texas and Louisiana. The subspecies *traviatum* ranges from Massachusetts to northern Georgia, occurring east of the Appalachians. The extreme pale color of the type *westfalli* is not characteristic of the subspecies throughout most of its range.

In 1964 I described the new species *Enallagma westfalli* from eastern Texas, commenting that, ". . . clearly *westfalli* is congeneric with *traviatum* Selys and equally clearly with *pallidum* Root and *daeckii* (Calvert)." I also redefined the subgenus *Teleallagma* Kennedy, including in it *westfalli* with *pallidum* and *daeckii*. The principal